Attorney's Docket No. R60999 1180.5 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant(s): Crooks et al.
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Art Unit: 1791
Examiner: Felton, Michael J.
Title: FILTERED CIGARETTE INCORPORATING AN ADSORBENT MATERIAL

Docket No.: R60999 1180.5 (formerly 030627/267415)
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APPEAL BRIEF UNDER 37 CFR § 41.37

This Appeal Brief is filed pursuant to the "Notice of Appeal to the Board of Patent Appeals and Interferences" filed January 28, 2010, which was filed in response to the Office Action dated October 28, 2010.

1. ***Real Party in Interest.***

The real party in interest in this appeal is R. J. Reynolds Tobacco Company, the assignee of the above-referenced patent application.

2. ***Statement of Related Cases.***

There are no related appeals, continuing applications, or interferences involving this application or its subject matter.

3. **Status of Claims.**

Claims 1-21, 27, 28, 38, and 40-44 are pending and all stand rejected as unpatentable over a combination of prior art references as set forth in greater detail below. Claims 26 and 39 are canceled. Claims 22-25 and 29-37 are withdrawn. All rejections of record are appealed herein. Accordingly, all of claims 1-21, 27, 28, 38, and 40-44 are appealed herein.

4. **Status of Amendments.**

All claim amendments presented during prosecution have been entered and are set forth in the clean copy of the pending claims appended to the brief. Claim 1 was amended five times during prosecution. Claims 22 and 38 were amended twice during prosecution. Claims 2, 3, 5, 6, 23, 27, 29, and 30, 40, and 41 were amended once during prosecution.

5. **Summary of Claimed Subject Matter**

The present invention is directed to a smoking article (i.e., a cigarette) that possesses filter elements. Specifically, the cigarette incorporates an adsorbent material that is beneficial for adsorption of one or more gas phase constituents of mainstream smoke. The filter elements are capable of removing condensable gas phase components (such as carbonyl compounds – e.g., acetone, formaldehyde, acrolein, and acetaldehyde) from mainstream tobacco smoke to a significant degree. The cigarette generally comprises a tobacco rod with the filter element connected to the tobacco rod, the filter element having an end proximal to the tobacco rod and an end distal to the tobacco rod.

Independent claim 1 of the present application recites a cigarette comprising a tobacco rod and a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein said filter element comprises: a first longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod and which consists of filaments having a first weight per unit length; a second longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart from said first section of filter material and which consists of

filaments having a second weight per unit length, the two sections of filter material defining a compartment therebetween, wherein said first section of filter material has a greater particulate removal efficiency than said second section of filter material resulting from said first weight per unit length being lower than said second weight per unit length; a semi-permeable barrier dividing said compartment into region A and region B, wherein the barrier comprises a porous paper or a fibrous tow material; an adsorbent material contained within region A of said compartment; and an ion exchange resin contained within region B of said compartment. The cigarette structure generally comprising the tobacco rod and the filter element is described at page 6 (line 30) through page 8 (line 10) of the specification. The fibrous tow filter material is described at page 9 (line 19) through page 10 (line 5). The filter element is described more specifically in relation to Figures 2-10 at page 15 (line 16) through page 26 (line 10). The effect of the weight per unit length of the filaments is described at page 25 (lines 9-24). The division of the compartment between the two sections of filter material is described at page 17 (line 12) through page 21 (line 17). The adsorbent material and the ion exchange resin are described at page 19 (line 27) through page 20 (line 25).

Independent claim 38 of the present application recites a cigarette comprising a tobacco rod and a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein said filter element comprises: a first longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod and which consists of filaments having a first weight per unit length; a second longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart from said first section of filter material and which consists of filaments having a second weight per unit length, the two sections of filter material defining a compartment therebetween, wherein said first section of filter material has a greater particulate removal efficiency than said second section of filter material resulting from said first weight per unit length being lower than said second weight per unit length; an adsorbent material contained within said compartment; and an ion exchange resin contained within said compartment or dispersed within one or both of said first and second sections of filter material. The sections of the specification described above in relation to independent claim 1 also disclose the subject matter of independent claim 38.

6. ***Grounds of Rejection to be Reviewed.***

Claims 1-17, 19-21, 27, 28, 38, and 40-44 stand rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Jupe et al. (WO 02/060745 or U.S. 2002/0166563) in view of Chapman (RJR Memorandum, 1982), Schreus et al. (U.S. 2,815,760), and Applicant's described art.

Claim 4 stands rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Jupe et al., Chapman, Schreus et al. (U.S. 2,815,760), and Applicant's described art, and further in view of the *Kirk-Othmer Encyclopedia of Chemical Technology*, John Wiley & Sons, Inc., 2001, vol. 14, page 12.

Claim 18 stands rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Jupe et al., Chapman, Schreus et al. (U.S. 2,815,760), and Applicant's described art, and further in view of Frund (U.S. 5,714,126)

7. ***Argument.***

In all rejections, the Examiner relies upon the combination of the Jupe reference and the Chapman reference as allegedly teaching the general concept of the present claims. Specifically, the Examiner argues that the Jupe reference suggests use of a filter with a mouth end filter segment having a lower particulate removal efficiency than the tobacco end filter segment, and the Examiner argues

that the Chapman reference teaches that pressure drop decreases with decrease in denier. In maintaining the rejections, Applicant submits that the Examiner has not applied the proper standard for an obviousness evaluation and has failed to give proper consideration to evidence that undermines the Examiner's basis for the rejection. Applicant submits that this arises from a basic misunderstanding by the Examiner of what is disclosed by the art versus what is claimed in the present invention and by the Examiner's inability to disregard knowledge of the present invention in making an evaluation of what one of skill in the art would have taken from the cited art at the time of filing of the present patent application.

A. The Examiner Fails to Recognize the Distinction Between the Units of Denier and the Units of Denier Per Filament

The Applicant previously has pointed out that total denier, as discussed in Chapman, likely would be understood as referring to the total denier as a measure of total filter rod weight. By this use of the unit, a decrease in total filter weight would be expected to result in a decrease in pressure drop. In other words, where everything else is equal including denier per filament and filter cross-sectional area, one would expect pressure drop to decrease as the mass of filter material decreases because there is less fiber material present to restrict gas flow. On the

other hand, denier per filament refers to the size of individual filaments. Understanding this clarifies that a decrease in denier per filament indicates the presence of smaller fibers that are more densely packed to achieve the same total filter weight. A denser packing of the fibers having a smaller denier per filament would result in an increase in pressure drop. In other words, denier per filament and pressure drop are inversely proportional. Increases in denier per filament would result in decreases in pressure drop, and decreases in denier per filament would result in increases in pressure drop.

The Examiner quotes Chapman as suggesting that pressure drop decreases as denier decreases. In light of the discussion above, Applicant submits that Chapman cannot be referring to denier per filament – the unit used in the present claims (i.e., the mass per unit length of the individual filaments) – but rather refers to total denier. In the Advisory Action mailed April 1, 2010, the Examiner argued that it doesn't matter whether Chapman teaches a direct proportion or an inverse proportion between unit size and pressure drop so long as Chapman teaches the existence of some relationship. Applicant submits the teaching is critical, however, because the relationship Chapman discusses is the relation between denier and pressure drop. Chapman does not teach the relationship between pressure drop and denier per filament – the unit that is actually being claimed.

When the proper unit is considered, the Chapman reference does not take on the role alleged by the Examiner, and the obviousness arguments must fail.

B. When the Correct Unit is Considered, the Pending Rejection is Not Supported by the Cited Art

In making the rejection, the Examiner argues that Chapman teaches that it is known that pressure drop decreases with decrease in denier and fiber cross-sectional area. Thus, a skilled person viewing Chapman would be motivated to consider a relationship between denier and pressure drop. Applicant submits that this disclosure would not apprise a skilled person to as to the existence of any specific relationship between denier per filament and pressure drop. The significance of this distinction is evidenced by the fact that the relationship between pressure drop and denier is a direct relationship, but the relationship between pressure drop and denier per filament is an inverse relationship. Thus, Applicant submits that nothing in Chapman art would lead a skilled person to the claimed invention.

In support of this distinction, Applicant previously directed the Examiner's attention to U.S. Pat. No. 4,522,616 to Hyde et al. As shown in Fig. 4, as denier per filament (or dpf) decreases, pressure drop through a cigarette rod increases.

For example, the pressure drop through a rod constructed of 1.8 dpf fibers is clearly much higher than pressure drop through a rod constructed of 8.0 dpf fibers. This is clear evidence that the phenomenon by which the Applicant has arrived at the present invention is not suggested by Chapman. Again, Applicant submits that Chapman teaches total denier as a measure of total filter rod weight, and Chapman concludes that decreases in total filter weight will result in decreases in pressure drop. This is consistent with the teachings of the Hyde patent, which shows that pressure drop increases with increasing filter rod weight (see Fig. 4 which plots rod weight versus pressure drop). In other words, where everything else is equal including denier per filament and filter cross-sectional area, one would expect pressure drop to decrease as the mass of filter material decreases. Accordingly, it is respectfully submitted that Chapman would not be read as suggesting that decreases in denier per filament decreases pressure drop.

C. The Examiner Has Not Correctly Evaluated the Teaching of the Jute Reference

As Applicant has previously noted, the Jupe reference, when properly read for its teachings in the document *as a whole*, would be viewed as teaching away from the claimed invention. The Examiner has argued that the Jupe reference

fairly teaches both a high and low filter efficiency in the tobacco end section of a filter element. Applicant disagrees. Instead, the Jupe reference clearly and unequivocally states that:

- All components of the exemplified filter rods should have "low particulate efficiency"; and
- The tobacco end component 18 should have the lowest particulate efficiency because it is upstream of the ventilation.

See paragraph bridging pages 11 and 12, second paragraph of page 13, and claim 8.

The above teachings are clearly shown in Table 1 on page 12, where the tobacco end component has the highest denier per filament (5.0) (and thus the lowest particulate efficiency) and the mouth end segment has a lower denier per filament (3.0). The Examiner appears to focus on the exemplary filter configuration of Jupe given in Table II; however, the teachings of a reference must be considered in the context of the whole document. While it is true that the percentage particulate efficiency range given for the tobacco end component in Table II has a higher upper end than the range for the mouth end component, the two ranges overlap and the range for the tobacco end component has the same lower limit as the mouth end segment. Applicants note that the exemplary filter of

Table III also illustrates overlapping ranges for particulate efficiency and RTD as between the mouth end component and the tobacco end component. In Table III, both the mouth end component and the tobacco end component have the same RTD range and an almost identical particulate efficiency range. Again, taking into consideration the teachings of the reference as a whole, one of ordinary skill in the art would seek to construct a filter where the tobacco end segment is at least as low, if not lower, in terms of denier per filament and particulate efficiency as compared to the mouth end segment. This is consistent with the exemplified filters described in Jupe and the admonition in the reference that the tobacco end segment should have the lowest particulate efficiency. Accordingly, Applicant submits that the Examiner has not fairly considered the actual teaching of Jupe as a whole, particularly that Jupe does not teach the claimed differences in denier per filament.

In addition to the foregoing, Applicant specifically directs attention to the specific denier per filament ranges set forth in claims 27 and 28. Such express recitations provide even greater distinctions between the cited art and the claimed invention. Both claims recite that the tobacco end segment comprises filaments having a weight per unit length of less than about 2.5 denier per filament (e.g., about 1.8 to about 2.5 denier). The Jupe reference does not teach or suggest the use of such low denier per filament values for either a mouth end component or a

tobacco end component. Table I uses values of 3.0 for the mouth end segment and 5.0 for the tobacco end segment. The footnote after Table III suggests denier per filament values of 3-8. Accordingly, these claims are separately patentable over the cited art.

D. The Examiner Has Not Given Fair Weight to Exemplary Evidence Presented by the Applicant

Applicant previously pointed the Examiner to the Exemplary evidence provided in the originally filed application and the unexpected results illustrated therein in relation to the claimed filter configuration. In Example 1, a cigarette comprising a centrally-located adsorbent material is formed and tested with a tobacco end filter segment having a lower particulate removal efficiency (i.e., a mouth end segment having a denier per filament of 2.5 and a tobacco end segment having a denier per filament of 8.0). In Example 2, the filter segments were reversed, the tested cigarette comprising a 2.5 dpf tobacco end segment and an 8.0 dpf mouth end segment. As set forth in Example 2, the cigarette having the claimed filter configuration provided greater reduction in certain mainstream smoke components as compared to the cigarette with the reverse configuration.

There is nothing in the cited art to suggest such a result and in fact, as noted above, the Jupe reference counsels against using the claimed filter configuration.

E. The Examiner Has Not Applied the Proper Standard in Evaluating Obviousness

MPEP 2142 sets forth the basic standard for evaluating obviousness in light of the prior art identified by the Examiner and evidence to the contrary provided by the Applicant. If the examiner determines there is factual support for rejecting the claimed invention under 35 U.S.C. 103, the examiner must then consider any evidence supporting the patentability of the claimed invention, such as any evidence in the specification or any other evidence submitted by the applicant. The ultimate determination of patentability is based on the entire record, by a preponderance of evidence, with due consideration to the persuasiveness of any arguments and any secondary evidence. *In re Oetiker*, 977 F.2d 1443 (Fed. Cir. 1992). With regard to rejections under 35 U.S.C. 103, the examiner must provide evidence which as a whole shows that the legal determination sought to be proved (i.e., the reference teachings establish a *prima facie* case of obviousness) is more probable than not. Applicant submits this standard has not been applied in light of evidence submitted by the Applicant.

When an applicant submits evidence, whether in the specification as originally filed or in reply to a rejection, the examiner must reconsider the patentability of the claimed invention. The decision on patentability must be made based upon consideration of all the evidence, including the evidence submitted by the examiner and the evidence submitted by the applicant. A decision to make or maintain a rejection in the face of all the evidence must show that it was based on the totality of the evidence. Facts established by rebuttal evidence must be evaluated along with the facts on which the conclusion of obviousness was reached, not against the conclusion itself. *In re Eli Lilly & Co.*, 902 F.2d 943, 14 USPQ2d 1741 (Fed. Cir. 1990).

Applicant specifically directs attention to the decision of *In re Piasecki*, 745 F.2d 1468 (Fed. Cir. 1984), wherein the court noted the following:

> When prima facie obviousness is established and evidence is submitted in rebuttal, the decision-maker must start over.... An earlier decision should not, as it was here, be considered as set in concrete, and applicant's rebuttal evidence then be evaluated only on its knockdown ability. Analytical fixation on an earlier decision can tend to provide that decision with an undeservedly broadened

umbrella effect. Prima facie obviousness is a legal conclusion, not a fact. Facts established by rebuttal evidence must be evaluated along with the facts on which the earlier conclusion was reached, not against the conclusion itself.

In the present case, Applicant respectfully submits the Examiner has not followed this legal standard. The Examiner has made decisions based upon whether it was believed that the submitted evidence overcame the obviousness conclusion, not whether the evidence as a whole, including the evidence of non-obviousness, supported patentability. For example, the Examiner has disregarded the evidence provided in relation to the Hyde patent teaching that pressure drop through a cigarette rod increases as denier per filament decreases. The Examiner likewise has disregarded evidence showing that the denier unit and the denier per filament unit are distinct and different and have different effects on pressure drop through a cigarette rod. The Examiner persists in arguing that as long as a relationship between denier and pressure drop is suggested, that is the end of the story. That is an incorrect analysis, though, under prevailing case law. The Examiner must consider the difference between the denier unit and the denier per filament unit and must consider what a skilled person would be motivated to try

with the knowledge of such difference and the knowledge of the Hyde patent teaching a clearly different proportionality than relied upon by the Examiner.

The Examiner likewise has not given fair weight to the teaching of surprising results provided in the examples of the present invention. Again, it is proper for the Examiner to consider all of the evidence as a whole and weigh whether the evidence in its totality supports as finding that the claimed subject matter is obvious. Rather, the Examiner has made an initial decision and has merely considered evidence of non-obviousness for its "knock-down effect." The case law does not support such an evaluation.

To this end, Applicant submits that when the evidence in its totality is evaluated, a finding of obviousness cannot be supported. The cited art – particularly Jupe and Chapman – does not disclose or suggest the claimed invention in relation to the use of two distinct sections of filter material, wherein the first section has a greater particulate removal efficiency than the second section resulting from the weight per unit length in the first section being lower than the weight per unit length in the second section.

- The Examiner's original determination of obviousness was based on a misunderstanding of the distinction between the unit denier and the unit denier per filament.

- When the distinction was pointed out, the Examiner brushed it aside arguing that the mere existence of a relationship was sufficient regardless of the proportionality thereof. To this end, the Examiner virtually ignored evidence in the form of the Hyde patent, which supported Applicant's position and severely undermined the Examiner arguments.
- The Examiner disregarded the fact that different units result in different proportionalities – thus the Examiner's conclusion is not supported by what the art actually teaches.
- The Examiner did not properly consider the effect of the test results illustrated by the exemplary evidence of the originally filed specification when it was pointed out after the original conclusion of obviousness.

In light of the foregoing, Applicant submits the Examiner has not applied a proper legal analysis in making a final conclusion of obviousness. The Examiner has formed an initial conclusion on the matter and has only considered rebuttal evidence as to whether the rebuttal evidence was sufficient to overcome the initial conclusion. As pointed out in case law, this gives an improperly broad effect to the initial conclusion. After being presented with the full evidence of non-obviousness and the correct interpretation of the units that are central to the determination, the Examiner has not made the obviousness evaluation anew in consideration of the

evidence as a whole. When the proper evaluation is made and the evidence as a whole is considered, Applicant submits that the evidence does not support a conclusion of obviousness.

8. Claims Appendix.

An appendix containing a copy of the claims involved in the appeal is attached.

9. Evidence Appendix

An appendix containing documents provided during prosecution to support arguments of patentability is attached.

10. Related Proceedings Appendix

There are no decisions by a court or the Board in related proceedings.

11. Conclusion

In light of the foregoing, Applicant submits that the pending claims are not obvious over the art of record, and Applicant submits that a correct evaluation considering the evidence as a whole in its proper context and meaning supports

Applicant's argument for patentability. Accordingly, Applicant respectfully requests a determination by the Board that the pending claims are allowable over the cited art and an order withdrawing the pending rejections.

Respectfully submitted,

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Claims Appendix

1. (Previously presented) A cigarette comprising a tobacco rod and a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein said filter element comprises:

a first longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod and which consists of filaments having a first weight per unit length;

a second longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart from said first section of filter material and which consists of filaments having a second weight per unit length, the two sections of filter material defining a compartment therebetween, wherein said first section of filter material has a greater particulate removal efficiency than said second section of filter material resulting from said first weight per unit length being lower than said second weight per unit length;

a semi-permeable barrier dividing said compartment into region A and region B, wherein the barrier comprises a porous paper or a fibrous tow material;

an adsorbent material contained within region A of said compartment; and

an ion exchange resin contained within region B of said compartment.

2. (Previously Presented) The cigarette of Claim 1, wherein region A of said compartment is adjacent to said first section of filter material and region B of said compartment is adjacent to said second section of filter material.

3. (Previously Presented) The cigarette of Claim 1, wherein region A of said compartment is adjacent to said second section of filter material and region B of said compartment is adjacent to said first section of filter material.

4. (Original) The cigarette of Claim 1, wherein said ion exchange resin is in granular form.

5. (Previously Presented) The cigarette of Claim 1, wherein said ion exchange resin is an anion exchange resin.

6. (Previously Presented) The cigarette of Claim 1, wherein said first section of filter material and said second section of filter material are each independently selected from the group consisting of cellulose acetate tow and polypropylene tow.

7. (Original) The cigarette of Claim 1, wherein said first section of filter material and said second section of filter material comprise plasticized cellulose acetate tow.

8. (Original) The cigarette of Claim 1, wherein the overall length of the filter element is about 15 to about 65 mm.

9. (Original) The cigarette of Claim 8, wherein the overall length of the filter element is about 25 to about 50 mm.

10. (Original) The cigarette of Claim 1, wherein the length of each of the first and second sections of filter material is about 5 to about 25 mm.

11. (Original) The cigarette of Claim 10, wherein the length of each of the first and second sections of filter material is about 5 to about 15 mm.

12. (Original) The cigarette of Claim 1, wherein the adsorbent-containing region and the ion exchange resin-containing region each has a length of about 5 to about 20 mm.

13. (Original) The cigarette of Claim 12, wherein the adsorbent-containing region and the ion exchange resin-containing region each has a length of about 5 to about 10 mm.

14. (Original) The cigarette of Claim 1, wherein the length of said semi-permeable barrier is about 0.1 to about 10 mm.

15. (Original) The cigarette of Claim 14, wherein the length of said semi-permeable barrier is about 0.5 to about 5 mm.

16. (Original) The cigarette of Claim 1, wherein said adsorbent is selected from the group consisting of activated carbon, molecular sieves, clays, activated aluminas, silica gels, and mixtures thereof.

17. (Original) The cigarette of Claim 1, wherein said adsorbent is activated carbon.

18. (Original) The cigarette of Claim 17, wherein the activated carbon has an activity of about 60 to about 150 Carbon Tetrachloride Activity.

19. (Original) The cigarette of Claim 1, wherein said adsorbent is in granular form.

20. (Original) The cigarette of Claim 19, wherein said adsorbent has a particle size of about 8x16 mesh to about 30x70 mesh.

21. (Original) The cigarette of Claim 1, wherein said semi-permeable barrier is selected from the group consisting of paper, cellulose acetate tow, gathered cellulose acetate web, polypropylene tow, gathered polypropylene web, and gathered polyester web.

22. (Withdrawn) A cigarette comprising a tobacco rod and a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein said filter element comprises:

a first longitudinally extending section of fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod;

a second longitudinally extending section of fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart from said first section of filter material, the two sections of fibrous tow filter material defining a compartment therebetween, wherein said first section of filter material has a greater particulate removal efficiency than said second section of filter material;

an adsorbent material contained within said at least a portion of said compartment; and

an ion exchange resin dispersed within one or both of said first and second sections of filter material.

23. (Withdrawn) The cigarette of Claim 22, wherein said first section of filter material comprises filaments having a lower weight per unit length than the filaments of said second section of filter material.

24. (Withdrawn) The cigarette of Claim 23, wherein said first section of filter material comprises filaments having a weight per unit length of less than about 2.5 denier per filament and said second section of filter material comprises filaments having a weight per unit length of greater than about 3.0 denier per filament.

25. (Withdrawn) The cigarette of Claim 24, wherein said first section of filter material comprises filaments having a weight per unit length of about 1.8 to about 2.5 denier per filament and said second section of filter material comprises filaments having a weight per unit length of about 3.0 to about 10 denier per filament.

26. (Cancelled)

27. (Previously Presented) The cigarette of Claim 1, wherein said first section of filter material comprises filaments having a weight per unit length of less than about 2.5 denier per

filament and said second section of filter material comprises filaments having a weight per unit length of greater than about 3.0 denier per filament.

28. (Previously Presented) The cigarette of Claim 27, wherein said first section of filter material comprises filaments having a weight per unit length of about 1.8 to about 2.5 denier per filament and said second section of filter material comprises filaments having a weight per unit length of about 3.0 to about 10 denier per filament.

29. (Withdrawn) A cigarette comprising a tobacco rod and a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein said filter element comprises:

a first longitudinally extending section of fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod;

a second longitudinally extending section of fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart from said first section of filter material, the two sections of filter material defining a compartment therebetween, wherein said first section of filter material has a greater particulate removal efficiency than said second section of filter material; and

an adsorbent material and an ion exchange resin contained within said compartment.

30. (Withdrawn) The cigarette of Claim 29, wherein said first section of filter material comprises filaments having a lower weight per unit length than the filaments of said second section of filter material.

31. (Withdrawn) The cigarette of Claim 30, wherein said first section of filter material comprises filaments having a weight per unit length of less than about 2.5 denier per filament and said second section of filter material comprises filaments having a weight per unit length of greater than about 3.0 denier per filament.

32. (Withdrawn) The cigarette of Claim 31, wherein said first section of filter material comprises filaments having a weight per unit length of about 1.8 to about 2.5 denier per filament and said second section of filter material comprises filaments having a weight per unit length of about 3.0 to about 10 denier per filament.

33. (Withdrawn) The cigarette of Claim 29, wherein said ion exchange resin and said adsorbent material are in granular form.

34. (Withdrawn) The cigarette of Claim 29, wherein said ion exchange resin is a strong base anion exchange resin or a weak base anion exchange resin.

35. (Withdrawn) The cigarette of Claim 29, wherein said first section of filter material and said second section of filter material comprise plasticized cellulose acetate tow.

36. (Withdrawn) The cigarette of Claim 29, wherein said adsorbent is selected from the group consisting of activated carbon, molecular sieves, clays, activated aluminas, silica gels, and mixtures thereof.

37. (Withdrawn) The cigarette of Claim 36, wherein said adsorbent is activated carbon.

38. (Previously Presented) A cigarette comprising a tobacco rod and a filter element connected to the tobacco rod, said filter element having an end proximal to the tobacco rod and an end distal from the tobacco rod, wherein said filter element comprises:

a first longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element proximal to the tobacco rod and which consists of filaments having a first weight per unit length;

a second longitudinally extending section of plasticized fibrous tow filter material positioned at the end of the filter element distal from the tobacco rod and spaced apart

from said first section of filter material and which consists of filaments having a second weight per unit length, the two sections of filter material defining a compartment therebetween, wherein said first section of filter material has a greater particulate removal efficiency than said second section of filter material resulting from said first weight per unit length being lower than said second weight per unit length;

an adsorbent material contained within said compartment; and

an ion exchange resin contained within said compartment or dispersed within one or both of said first and second sections of filter material.

39. (Cancelled)

40. (Previously Presented) The cigarette of Claim 38, wherein said first section of filter material comprises filaments having a weight per unit length of less than about 2.5 denier per filament and said second section of filter material comprises filaments having a weight per unit length of greater than about 3.0 denier per filament.

41. (Previously Presented) The cigarette of Claim 38, wherein said first section of filter material comprises filaments having a weight per unit length of about 1.8 to about 2.5 denier per filament and said second section of filter material comprises filaments having a weight per unit length of about 3.0 to about 10 denier per filament.

42. (Previously Presented) The cigarette of Claim 38, further comprising a semi-permeable barrier dividing said compartment into region A and region B.

43. (Previously Presented) The cigarette of Claim 1, further comprising a plurality of ventilation holes overlying the compartment.

44. (Previously Presented) The cigarette of Claim 43, wherein the ventilation holes are positioned between the midpoint of the adsorbent-containing portion of the compartment and the end of the compartment proximal to the tobacco rod.

Evidence Appendix

Provided hereafter is a copy of U.S. Patent No. 4,522,616 to Hyde et al.

United States Patent [19]

Hyde et al.

[11] **Patent Number: 4,522,616**

[45] **Date of Patent: Jun. 11, 1985**

[54] **METHOD AND APPARATUS FOR FORMING CIGARETTE FILTER RODS**

[75] Inventors: **Rebecca A. Hyde**, Charlotte; **Kenneth R. Krimminger**, Oakboro; **Robert E. Swander**, Charlotte, all of N.C.

[73] Assignee: **Celanese Corporation**, New York, N.Y.

[21] Appl. No.: 356,708

[22] Filed: Mar. 10, 1982

[51] Int. Cl.³ A24C 5/50

[52] U.S. Cl. 493/44; 493/50; 28/283

[58] Field of Search ..... 493/44, 48, 50, 42, 493/39; 19/65 T, 66 T; 28/283; 156/200, 166

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3,095,343	6/1963	Berger	28/283 X
3,099,594	7/1963	Caines et al.	156/152
3,106,501	10/1964	Cobb, Jr. et al.	493/43 X
3,173,188	3/1965	Wexler	156/200
3,204,295	9/1965	Amos	19/65 T X
3,380,131	4/1968	Gray	19/66 T X
3,636,825	1/1972	Randall et al.	226/195 X
3,831,501	8/1974	Bevington, Jr.	493/44
4,411,641	10/1983	Suzuki et al.	493/50 X

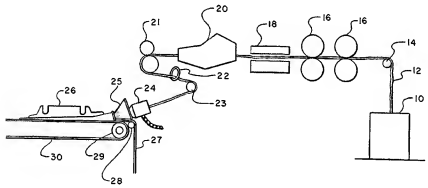
Primary Examiner—James F. Coan

Attorney, Agent, or Firm—Robert J. Blanke

[57] **ABSTRACT**

The present invention relates to high speed processes and apparatus for the manufacture of cigarette filter rods. In accordance with this invention it has been discovered that in a process of manufacturing filter elements from opened and deregistered crimped continuous filament tow, wherein said tow is conducted from a mechanical forwarding means through an aspirating jet positioned adjacent a compacting means and wherein means are provided for dissipating aspirating fluid, that filter rod pressure drop and weight variations are reduced by causing the opened and deregistered tow to contact a drag inducing tow width and direction controlling means positioned substantially intermediate said mechanical forwarding means and said aspirating jet.

9 Claims, 8 Drawing Figures



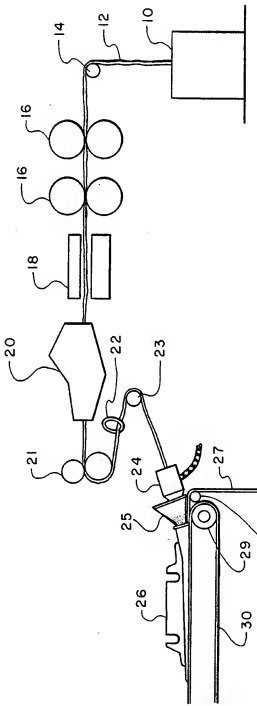


Fig. 1

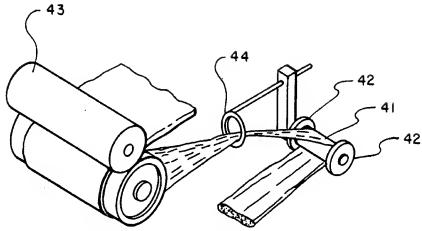


Fig. 2

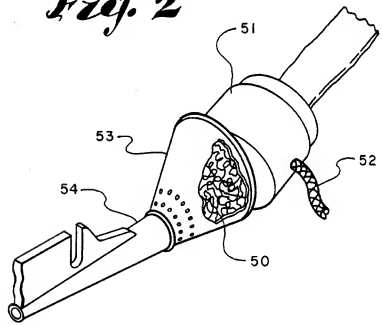


Fig. 3

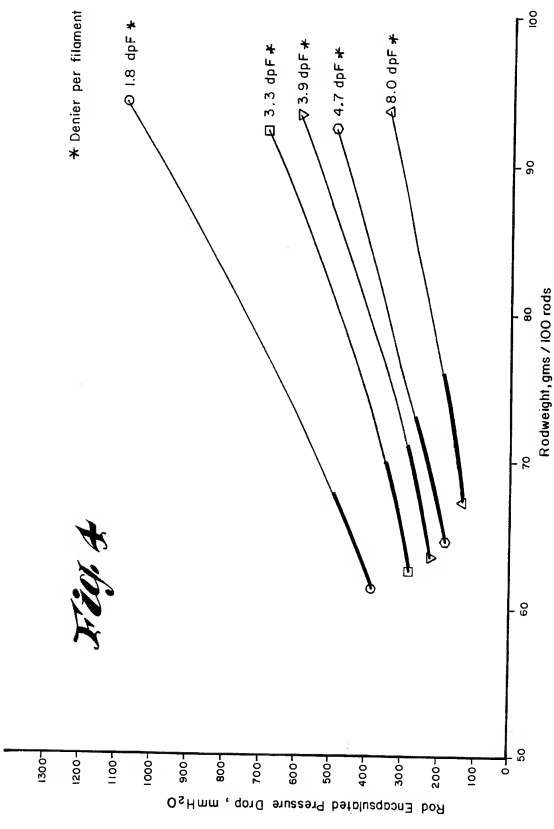

* Denier per filament
1.8 dpF *
3.3 dpF *
3.9 dpF *
4.7 dpF *
8.0 dpF *
Rod Encapsulated Pressure Drop , mm H2O
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
50
60
70
80
90
100
Rodweight, gms / 100 rods

Fig. 4

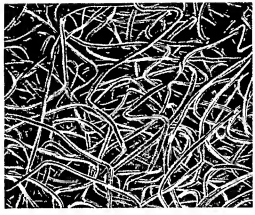


Fig. 5

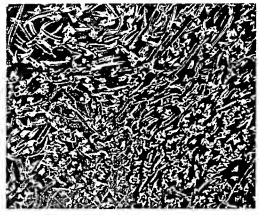


Fig. 6

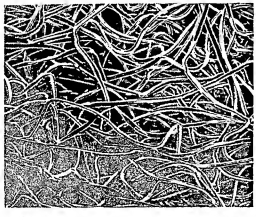


Fig. 7

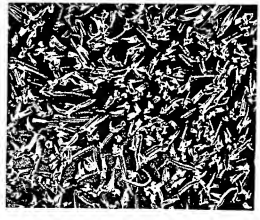


Fig. 8

METHOD AND APPARATUS FOR FORMING CIGARETTE FILTER RODS

The present invention relates to improved processes and apparatus for the production of cigarette filter rods from continuous filament tow. More specifically, the invention relates to improved high speed processes and apparatus for the production of cigarette filter rods of reduced variability having high tow utilization in terms of pressure drop per unit rod weight.

In the last decade, the overwhelming proportion of commercially available cigarette filters have comprised longitudinally extended crimped filaments bonded to one another at their contact points by solvation bonds. The procedure for producing such filters involves producing a tow or untwisted bundle of several thousand continuous filaments, crimping the tow, opening the tow to deregister adjacent crimps, fluffing the tow to permit subsequent uniform application of a plasticizer, pulling the tow through the zones of plasticizer application and thereafter treating the plasticized tow to reduce its cross-sectional size until it is approximately equal to the cross-sectional size of a cigarette. The condensed mass is formed into a coherent structure, typically by wrapping paper around it and severing the wrapped tow into rods of predetermined length and thereafter curing the rods to affect bonding between adjacent filaments at their contact points.

Because of the expense of the tow component of the cigarette filter, it is desirable that the greatest amount of tow crimp and hence, tow bulk be attained per unit weight of filamentary material. One widely-used method of opening the tow consists of subjecting the tow while being fed along a predetermined path to a differential gripping action between a plurality of points spaced from one another transversely of the path so that certain laterally-spaced sections of the tow are positively gripped relative to other laterally-spaced sections of the tow. In this manner, there is produced as a function of the differential positive gripping of the tow, a relative shifting of adjacent filaments longitudinally of the tow, whereby the crimps are moved out of registry with one another. The longitudinal relative displacement of the fibers usually is combined with a relative lateral displacement between adjacent filaments of the tow whereby the combination of the two relative filaments movements bring about a complete opening of the tow.

This differential gripping action is accomplished by the provision before the plasticizing chamber of a pair of rollers, one of which is a smooth surface and the other of which is grooved over its entire periphery. The tow is maintained under tension upstream of the differential gripping action so that after release of the tension on a downstream side of the differential gripping action, the tow blooms into a fluffy band which then passes through the plasticizer applying chamber, optionally after further lateral opening of the tow band, prior to feeding the tow band to the filter rod-making machine.

Another widely-used method of opening tow is that set forth in U.S. Pat. No. 3,099,594 wherein crimped continuous tow is fed into a jet supplied with high velocity gas whereby the crimp in the filaments is put out of registry. More specifically, in the process of U.S. Pat. No. 3,099,594, a continuous multifilament crimped tow is withdrawn from a supply package by means of a feed roll pair and passed by the suction of a blooming jet over a suitable plasticizer applicator into a blooming jet. In the blooming jet, the tow is subjected to an explosive expansion of compressed air while in the jet, the bloomed tow is exposed to a fog of atomized plasticizer liquid. The plasticized tow is expelled from the jet under the influence of the expanding air flow into a feed roll pair operated at a somewhat slower speed than the first feed roll pair so that the tow is in a state of relaxation. The opened, plasticized and crimp deregistered tow is then passed into a filter rod-making machine.

While in the production of cigarette filter rods, optimum openness is desirable, the exact value for optimum openness varies from tow product to tow product. For instance, when a low degree of deregistry between the individual filaments comprising a tow bundle occurs, the resultant filter rods produced from such a tow bundle are too soft, difficult to wrap initially in forming the rods as well as in joining the rods to tubes of tobacco and making cigarette filters, and which do not spring after compression (as between the fingers or lips during smoking) with attended channelling of the smoke. For the same reasons, the opening equipment should not operate so strongly on the tow that the crimps are pulled out and the tow is of diminished bulk; while this could be compensated for by utilizing heavier tows, the resultant plugs would be so dense as to make it exceedingly uncomfortable to draw smoke through the filter, i.e., its pressure drop would be too high. Additionally, the smoke removal efficiency of the filter rod must be maintained at acceptable levels.

One means for maximizing tow utilization, that is to say, improving pressure drop per unit rod weight, is set forth in U.S. Pat. No. 3,050,430. In U.S. Pat. No. 3,050,430, an improvement is set forth in the process sequence wherein filaments which have been previously opened up and treated with plasticizer are forwarded into a garniture for compacting and forming. Rather than employing a mechanical type of treatment to pull the filaments into the garniture whereby a substantial amount of crimp is lost, the Patentee pushes the band of open-continuous crimped filaments into the rod compacting and forming means. The filaments fed in this manner are in a somewhat relaxed and untensioned state whereby a relatively large percentage of each filament may be positioned somewhat crosswise or perpendicular to the longitudinal axis of the filament bundle. To achieve this result, a pneumatic transport or forwarding jet, such as that disclosed in U.S. Pat. No. 3,016,945, is positioned reasonably adjacent the tongue of a rod forming member or garniture. The tongue is perforated so that air or aspirating fluid employed to push the filamentary material into the tongue will be radially exhausted. Alternatively, as disclosed in U.S. Pat. No. 3,173,188, an inverted shroud may be positioned intermediate the forwarding jet and the perforated tongue whereby a substantial portion of the aspirating gas is caused to flow in a direction opposite the movement of the filaments or exhaust through small holes in the rear wall of the shroud or funnel member. This fluid dissipation is in addition to the radial exhaust which takes place in the perforated tongue member.

Regardless of the process for manufacturing filter rods, the filter rod must have a nominally constant cross-sectional size and should be of uniform mass per unit length. The pressure drop or resistance to air flow through the filter rod should also be constant along its length. The length of the filter tip which is combined

with a cigarette to form filter tip cigarettes may be in the range of 10 to 30 millimeters.

It is important from the smoker's point of view that the draw characteristics, the resistance to air flow through the length of filter rod, should be reasonably uniform. Some factors influencing the resistance to airflow along a filter rod are the fiber density, by which is meant the number of fibers per unit cross-sectional area; the denier of the fibers; the degree of crimping of the fibers; and the degree of fiber opening or "bloom". Some of these factors affect the mass per unit length of the filter rod so that variations of mass per unit length of the filter rod to some extent reflect variations in the resistance to airflow along the rod. The higher the mass per unit length of the rod the greater the resistance to airflow through that length of filter rod.

There is an ever increasing concern among filtered cigarette manufacturing companies with improving productivity and quality, reducing waste, and generally cutting costs. New high speed rod making machines run at speeds of 400 meters per minute or more. Prior art rod making processes are generally designed to run at speeds of about 200 meters per minute. When running at speeds of 400 meters per minute or more, it has been found that the maximum tow utilization processes of the prior art produced the aforementioned undesirable tow density variations. Tow density variations as previously noted are undesirable since the resistance which filter rod sections, including such variations offer to the passage of cigarette smoke, varies rendering inconsistent the draw characteristics of cigarettes to which filter tips formed from such filter rod sections are applied.

Accordingly, it is an object of this invention to provide a high speed process for the preparation of cigarette filter rods having high tow utilization in terms of pressure drop per unit rod weight without producing substantial tow density variations.

It is another object of this invention to provide high speed apparatus suitable for the preparation of a cigarette filter rod having high tow utilization in terms of pressure drop per unit rod weight without producing substantial tow density variations.

Other objects and advantages of the invention will become apparent from the following detailed description and claims taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a diagramatic view of an apparatus suitable for the practice of the present invention.

FIG. **2** is a perspective view of the idler roll arrangement used in the embodiment of FIG. **1**.

FIG. **3** is a perspective view of the perforated funnel arrangement used in the embodiment of FIG. **1**.

FIG. **4** is a graph plotting filter rod weight against pressure drop for cigarette tows of from 1.8 to 8.0 denier per filament.

FIG. **5** is a photomicrograph magnified 100 times of a longitudinal axis cross section of a range extended filter rod of this invention.

FIG. **6** is a photomicrograph magnified 100 times of a radial cross section of the filter rod of FIG. **5**.

FIG. **7** is a photomicrograph magnified 100 times of a longitudinal cross section of a prior art filter rod.

FIG. **8** is a photomicrograph magnified 100 times of a radial cross section of the filter rod of FIG. **7**.

In accordance with this invention, it has now been discovered that in a high speed process for the preparation of cigarette filter rods having high tow utilization in terms of the pressure drop per unit rod weight, that tow density and pressure drop variations may be minimized by positioning a tow controlling means downstream from the final set of feed rolls employed in a cigarette tow opening system, that is to say intermediate the feed rolls and the rod making device. The tow controlling means serves to control tow width and direction. The tow controlling means also serves to control tension by imparting at least some drag to the running tow band. Preferably, the tow controlling means is employed in conjunction with a rod making device having a pneumatic forwarding jet being positioned up-stream of a garniture of the rod making device, the tow controlling means being positioned so as to direct the tow path along the longitudinal axis of the pneumatic forwarding jet. Intermediate the pneumatic forwarding jet and the garniture of the rod making device it is preferred to position a perforated funnel member which has the ability to radially exhaust air from the pneumatic forwarding device. The funnel member should have a volume sufficient to allow tow to be over fed and accumulate in a relaxed state within the funnel. Preferably, the funnel should have a depth greater than or equal to three and one half inches, an entrance diameter of about 4 inches and an exit diameter of about one and one quarter inches. Most preferably the perforations of the funnel are positioned nearest the exit end of the funnel. The exit end of the funnel is recessed into the tongue of the garniture of the rod making device, while the pneumatic forwarding jet is recessed into the mouth of the funnel. It should be understood that the perforated tongue may be either perforated or un-perforated for purposes of the instant invention. Preferably, the tow width, tension and direction controlling means is either a rod or freely rotating roll. The rod or freely rotating roll is preferably about four to 10 inches long and most preferably four inches long and about one and one half inches in diameter and flanged at both extremies. The flanging is preferred in order that a tow band of desired width is achieved. Most preferably, a ring guide preceeds the tow controlling means so as to prereduce the band width prior to stabilization of the band width on the flanged rod or freely rotating roll. It should be understood that a fixed position of the rod or freely rotating roll is preferred in order to accurately control tow band direction, however, a floating mount of the rod or freely rotating roll, i.e. a dancer roll, may be employed where tension control is of greater importance.

For purposes of this invention, the pneumatic forwarding jet is preferably of cone-shaped construction, having a greater cross-section on the entrance end than on the exit end. The jet is fabricated such as to have inner and outer cone members which are joined so as to encircle a chamber, the jet being provided with means for the injection of a gas into the chamber. Air injected into the chamber exhausts at the small or exit end of the jet whereby a continuous filament tow may be motivated through the jet. Jets of this type are set forth in U.S. Pat. Nos. 3,050,430 and 3,016,945. A pneumatic forwarding or transport jet which has been found to be especially suitable is model number 61-0-0-DF marketed by Hauni-Werke Körber and Co. KG Hamburg, West Germany.

As previously noted, the process and apparatus of the instant invention provide a means for minimizing tow density variations in a high speed process for the preparation of cigarette filter rods having high tow utilization in terms of pressure drop per unit rod weight. By mini-

mizing tow density variations or weight variations pressure drop variations are also reduced. More specifically, it has been found that the process and apparatus of the instant invention will reduce pressure drop coefficient of variation to less than 3.0 and weight coefficient of variation to less than about 1.6 for any combination of weight and pressure drop of a given tow item at any rodmaker speed. The statistical investigation of the improvement obtained by the use of the apparatus and process of the instant invention is based on F-distribution. In F-distribution, when samples are taken from two independent populations, their variances are also independent and both S_1^2 and S_2^2 are unbiased estimators of the population variances, if the populations are infinite or if sampling with replacement. That is to say S_1^2 is an unbiased estimator of σ_1^2 (population standard deviation 1) and S_2^2 is an unbiased estimator of σ_2^2 (population standard deviation 2). The ratio of σ_1^2 to σ_1^2 is equal to 1.00 if the two variances are equal, and the mean ratio of S_1^2 to S_2^2 is also equal to 1.00 if the population variances are equal. If the two populations are both normal and have equal variances, then the ratio of the two sample variance values are distributed as F with $n_1 - 1$ and $n_2 - 1$ degrees of freedom.

The term coefficient of variation (CV) is a means for comparing the dispersion of two series by expressing the standard deviation as a percent of the mean of the series. In the instant invention, the mean of the series σ is a value encompassing 66% of all samples. The coefficient of variation (CV) may then be defined as follows:

$$CV = \frac{\text{average sample deviation}}{\text{average sample value}} \times 100$$

A better understanding of the invention may be had by turning to FIG. 1 of the drawings wherein a tow 12 of continuous cellulose acetate filaments, preferably having about 5 to 15 crimps per inch, an acetyl value of 38 to 41 percent, a circular or non-circular cross section, and a total denier of about 20,000 to about 120,000 or more is removed from a tow bale 10 and passed over guide means 14 to opener 16. The purpose of opener 16 is to cause deregistration of the crimps of the individual filaments and thus, provide a tow having improved uniformity and bulkiness. In the drawings, opener 16 is a threaded roll opener of the type generally described in U.S. Pat. No. 3,032,829 to Mahoney et al and U.S. Pat. No. 3,156,016 to Dunlap et al. Essentially, the threaded roll opener shown comprises two pairs of rolls with at least one roll of one pair being driven. Desirably, at least one roll of each pair has a patterned surface, preferably composed of circumferential or helical grooves. However, the roll pairs may be different, e.g. only one roll of one pair need be grooved. When the tow passes through the rolls, individual filaments of the tow are differentially restrained causing a longitudinal shifting of the relative location of the crimps of the individual filaments. It is to be understood of course, that other openers, for example, those producing deregistration by air turbulence or flexing of the tow may also be suitably employed.

After passing through opener 16, tow 12 is commonly passed through a banding jet 18 which spreads the tow by application of one or more air streams into a flat band of about 3 to 8 times its original width and causes further separation of the individual filaments. A suitable banding jet may be, for instance, that banding jet set forth in U.S. Pat. No. 3,226,773. However, other means for achieving filament separation, such as equipment utilizing electrostatic forces, are known in the art and may also be used for this purpose.

The open tow is then passed through plasticizer applicator 20 which treats the surface of the individual filaments with a plasticizing liquid, preferably an organic ester such as triacetin to cause bonding of the filaments. Other suitable plasticizers include, for example, triethyl citrate, dimethylethyl phthalate, or the dimethyl ether of triethylene or tetraethylene glycol. In the drawings, plasticizer applicator 20 may be a centrifugal plasticizer applicator of the type described in U.S. Pat. No. 3,387,992, which is a device employing a rotating disc for application of the plasticizer. Other applicators which are adapted to apply plasticizers to a continuous web include wick brush or spray nozzle type plasticizer applicators.

After treatment of the tow with plasticizer, the tow is passed into the nip of a pair of delivery rolls 21 through guide member 22. Guide member 22 reduces the width of the opened tow band prior to passage over idler roll 23.

After passing about idler roll 23, the open tow is passed to pneumatic forwarding jet 24 which may be a jet such as model number 61-0-0-DF marketed by Hauni-Werke Körber and Co. KG Hamburg, West Germany. Pneumatic forwarding jet 24 pushes the open tow through perforated funnel member 25 which is positioned in the tongue of garniture member 26. Garniture member 26 is also supplied with suitable wrapping paper 27 by means of driven roll 28, both wrapping paper 27 and tow 12 being supported by means of endless belt member 30 which is driven by means of roller member 29.

A better understanding of the geometry of the idler roll may be had from FIG. 2 of the drawing. In FIG. 2 it may be seen that idler roll 41 has flanged members 42 secured to the terminal portions thereof. Tow passing from the nip of a pair of driven feed rolls 43 is caused to be compressed in width by passage through ring guide 44. The tow band is then passed from ring guide 44 about idler roll 41 whereby the tow band width is precisely controlled at about four inches and the direction of feed of the tow band to the rod forming device is determined. As previously noted the tow band should be fed into the pneumatic forwarding jet along the longitudinal axis of the jets processing bore, that is to say, the tow band should not ride on the edge portion of the entrance orifice of the pneumatic forwarding jet. This configuration may be clearly seen in FIG. 3 of the drawings wherein the tow controlled at a predetermined width enters pneumatic forwarding jet 51, pneumatic forwarding jet 51 being equipped with air supply line 52. Pneumatic forwarding jet 51 is recessed into funnel member 53. Funnel member 53 has perforations positioned near the exit end thereof and is recessed into garniture tongue member 54. Perforations of funnel member 53 allow air from pneumatic forwarding jet 51 to escape radially to the path of the tow being advanced into the filter rod forming device. Preferably, funnel member 53 is perforated at the funnel exit portion. As previously noted, funnel member 53 has sufficient volume to allow the tow to be over fed and accumulate in a relaxed state within funnel member 53 without over flowing and, consequently snagging on the edge portion of funnel member 53. As can be seen in FIG. 3 of the drawings, funnel member 53 is partially broken, illus-

trating the accumulation of over fed tow **50** within funnel member **53**.

A further understanding of the invention will be had from the following examples which illustrate the improvement in tow density variation obtained from the process and apparatus of this invention, in the preparation of cigarette filter rods having high tow utilization in terms of pressure drop per unit rod weight.

EXAMPLE 1

Filter rods were prepared from 3.3 denier per filament, F cross section cellulose acetate tow having a total denier of 44,000 using the embodiment depicted in FIG. 1 of the drawings at running speeds of 400 meters per minute, the run being for a period of 45 minutes with samples being taken every 5 minutes. Twenty five rods are selected from the aforementioned 8 sample portions, the rods having preselected circumferences of 24.8 plus or minus 0.05 millimeters. In order to eliminate possible variations induced by the addition of plasticizer however, plasticizer was not added as illustrated in FIG. **1** of the drawings, but rather the tow line was passed through the plasticizer apparatus running empty. The weight and encapsulated pressure drop of 102 millimeter rod lengths were determined and were found to be as follows.

Pressure Drop (E Δ P) = 590 mm water	Weight = .8911 grams
σ = 15.8	σ = .0106
Coefficient of Variation (CV) = 2.67	Coefficient of Variation (CV) = 1.19

EXAMPLE 2

The process of Example 1 was repeated except that running speeds were reduced to 200 meters per minute. Weight and encapsulated pressure drop for 102 millimeter rod lengths were found to be as follows:

Pressure Drop (E Δ P) = 607 mm water	Weight = .9091 grams
σ = 17.7	σ = .0144
Coefficient of Variation (CV) = 2.91	Coefficient of Variation (CV) = 1.57

EXAMPLE 3

The process of Example 1 was repeated except that tow **12** is not passed through ring guide **22** and about idler roll **23** but rather is transmitted directly from drive rolls **21** to pneumatic forwarding jet **24**, the entry angle of the tow into pneumatic forwarding jet **24** being appropriately adjusted so as to eliminate any tow drag upon entry into pneumatic forwarding jet **24**. The weight and encapsulated pressure drop of 102 millimeter rod lengths were determined and found to be as follows.

Pressure Drop (E Δ P) = 608 mm water	Weight = .9080 grams
σ = 23.4	σ = .0143
Coefficient of Variation (CV) = 3.85	Coefficient of Variation (CV) = 1.56

EXAMPLE 4

The process of Example 3 was repeated except that running speeds of 200 meters per minute are employed. The weight and encapsulated pressure drop of 102 millimeter long rod lengths are determined and found to be as follows.

Pressure Drop (E Δ P) = 597 mm water	Weight X = .8670 grams
σ = 24.47	σ = .0166
Coefficient of Variation (CV) = 4.10	Coefficient of Variation (CV) = 1.91

EXAMPLE 5

The process of Example 1 was repeated except that the rod forming apparatus of U.S. Pat. No. 3,173,188 was employed, the funnel or shroud configuration being substantially as set forth in FIGS. **3** and **4** of the drawings. The perforated tongue of U.S. Pat. No. 3,173,188 was also employed rather than a unperforated tongue of FIG. **1** of the drawings of the instant invention. Weight and encapulated measure drop for 102 mm. rod lengths were found to be as follows:

Pressure Drop (E Δ P) = 578 mm water	Weight = .8769 grams
σ = 25.8	σ = 0.0150
Coefficient of Variation (CV) = 4.5	Coefficient of Variation (CV) = 1.71

EXAMPLE 6

The process of Example 5 was repeated except that running speeds were reduced to 200 meters per minute. Weight and encapsulated pressure drop for 102 mm. rod lengths were found to be as follows:

Pressure Drop (E Δ P) = 650 mm water	Weight X = .9219 grams
σ = 33.3	σ = .022
Coefficient of Variation (CV) = 5.1	Coefficient of Variation (CV) = 2.33

EXAMPLE 7

Filter rods were prepared from 3.3 denier per filament, F-cross section cellulose acetate tow having a total denier of 44,000 using the tow opening system as set forth in FIG. **2** of U.S. Pat. No. 3,099,594. However, in order to eliminate possible variations induced by the addition of plasticizer, the tow opening system was

operated without the use of plasticizer. After exiting feed rolls 7 as illustrated in FIG. 2 of U.S. Pat. No. 3,099,594, the opened deregistered tow was processed as illustrated in FIG. 1 of the drawings of the instant invention, that is to say, the opened deregistered tow was then passed through ring guide 22 of FIG. 1 of the drawings of the instant invention. Rod maker speeds of 400 meters per minute were employed. The weight and encapsulated pressure drop of 102 millimeter rod lengths were determined and were found to be as follows.

Pressure Drop (E Δ P) = 682 mm water	Weight = 0.9557 grams
σ = 20.8	σ = 0.013
Coefficient of Variation (CV) = 3.05	Coefficient of Variation (CV) = 1.36

EXAMPLE 8

Filter rods were prepared from 3.3 denier per filament, F-cross section cellulose acetate tow having a total denier of 31,000 using the embodiment depicted in FIG. 1 of the drawings at a running speed of 400 meters per minute. Running conditions were adjusted such that an average pressure drop of 259 mm. of water and an average rod weight of 0.6311 grams was obtained. Rods monitored over a 24 hour period were found to have an average FILTRONA hardness of 90.4%.

EXAMPLE 9

Filter rods were prepared from 3.9 denier per filament, F-cross section cellulose acetate tow having a total denier of 39,000 using the embodiment depicted in FIG. 1 of the drawings except that tow 12 is not passed through ring guide 22 and about idler roll 23 but rather is transmitted directly from drive rolls 21 to pneumatic forwarding jet 24, the entry angle of the tow into pneumatic forwarding jet 24 being appropriately adjusted so as to eliminate any tow drag upon entry into pneumatic forwarding jet 24. Running speeds of 400 meters per minute were employed and operating conditions were adjusted so as to obtain an average rod pressure drop of 251 mm. of water and an average rod weight of 0.6609 grams. Over a 24 hour period rods were found to have an average Filtrona hardness value of 90.3%.

EXAMPLE 10

The process of Example 8 was repeated except that running conditions were adjusted so that an average rod pressure drop of 267 mm. of water and an average rod weight of 0.6394 was obtained. Rods monitored over a 24 hour period were found to exhibit an average Filtrona hardness of 90.4%.

EXAMPLE 11

The process of Example 9 was repeated except that 3.3 denier per filament, F-cross section cellulose acetate tow having a total denier of 35,000 was employed. Running conditions were adjusted such that an average rod pressure drop of 281 mm. of water and an average rod weight of 0.6462 grams was obtained. Over a 24 hour period the rods are found to exhibit an average filtrona hardness of 90.2%.

EXAMPLE 12

The process of Example 8 was repeated except that running conditions were adjusted as such that an average rod pressure drop of 293 mm. of water and an average rod weight of 0.6741 grams was obtained. Rods monitored over a 24 hour period were found to exhibit an average Filtrona hardness of 92.4.

EXAMPLE 13

The process of Example 9 is repeated except that 4.2 denier per filament, F-cross section cellulose acetate tow having a total denier of 40,000 is employed. Running speeds are adjusted such that an average rod pressure drop of 304 mm. of water and an average weight of 0.7479 grams is obtained. Over a 24 hour period rods are found to exhibit an average Filtrona hardness value of 94.4%.

It is apparent from the foregoing Examples and more specifically Examples 1 to 4, that the process and apparatus of the instant invention significantly reduces filter rod weight and pressure drop coefficient of variation at running speeds in the range of 200 to 400 meters per minute. Examples 5 and 6 show that the prior art process and apparatus are represented by U.S. Pat. No. 3,173,188 do not, at comparable running speeds, achieve the coefficient of variation reductions obtained with the process and apparatus of the instant invention. Example 7 is illustrative of the applicability of the process and apparatus of the instant invention to other tow opening systems. Example 8 to 13 are illustrative of the improvement in filter rod hardness obtained by the process and apparatus of the instant invention. That is to say, at substantially equivalent rod pressure drops, equivalent hardness values are obtained at substantially lower rod weights when the process and apparatus of the instant invention is employed.

Pressure drop as reported in the preceeding examples is measured by the following method: Air is drawn through a 102 millimeter length of the fully encapsulated filter at a steady rate of 1050 cubic centimeters per minute and the resulting pressure difference across the filter is measured by means of a water manometer. The result is expressed in millimeters of water gauge.

Cigarette filter rod hardness as reported in the preceeding examples is measured by means of a "FILTRONA" Tester (manufactured by Cigarette Components Limited), by a test in which rod (for example a length of 102 millimeters) having a mean diameter (D), of about 7.8 millimeters, is compressed between two plates provided in the instrument. The rod is subjected to compression for 15 seconds by a load of 300 grams applied to opposite sides of the cylindrical surface of the rod and the average depression (A), that is the decrease in diameter of the rod, measured. The hardness is the diameter of the sample measured at a load of 300 grams and expressed as a percentage of the original diameter, that is, it is given by the following formula:

$$\text{Hardness } \% = [(D-A)/D] \times 100$$

The average value for 100-rod samples obtained at the minimum and maximun weight levels define the weight range capability and the pressure-drop range capability of a specific tow item. These values are fairly constant under equivalent processing conditions. The improved versatility of tow items as a result of this invention is illustarted by FIG. 4 of the drawings

wherein rod weight in grams is plotted against rod pressure drop of millimeters of water. As can be seen in FIG. 4 of the drawings a vastly extended filter rod range is obtained for 1.8 to 8.0 denier per filament tow items, the light line being representative of rods produced according to the teachings of the instant invention while the heavy line is representative of the same tow item processed according to the prior art. It should be noted that for each tow item, the relationship between the rod pressure drops for each tow item and the rod weight necessary to obtain that pressure drop is less than would be expected by linear extrapolation.

A better understanding of the reason for the improved range extension as illustrated in FIG. 4 of the drawings may be had by turning to FIGS. 5 thrcngh 8 of the drawings. FIG. 5 is a photomicrograph magnified 100 times of a cross section of a filter plug of the instant invention, the cross section being taken through the longitudinal axis of the plug. The rod was prepared from 3.3 denier per filament F-cross section tow having a total denier of 39,000, the rod being prepared substantially according to the process set forth in Example 1. As can be seen in FIG. 5, the individual filament plugs are positioned in a direction approaching cross wise, that is to say perpendicular, to the longitudinal axis of the filament bundle. FIG. 6 is a photomicrograph of a radial cross section of the filter rod of FIG. 5 of the drawings. As can be seen, the filaments are tightly packed which is indicative of the increased rod weight potential existing by utilization of the process and apparatus of the instant invention.

In contradistinction to the filament positioning of the rod of FIGS. 5 and 6 of the drawings, a significantly different filament positioning may be seen in a prior art filter plug as represented by FIGS. 7 and 8 of the drawings. FIG. 7 is a photomicrograph magnified 100 times of a cross section taken through the longitudinal axis of the plug, the plug being prepared substantially according to the process set forth in Example 3.The plug is prepared from 3.3 denier per filament F-cross section tow having a total denier of 39,000. As can be seen in FIG. 7, the filter rod has a minimal number of filaments which are positioned perpendicular to the longitudinal axis of the filament bundle. Moreover, as can be seen in FIG. 8 of the drawing which is a radial cross section of the filter rod of FIG. 7, the filaments are much less tightly spaced when compared with the filaments of FIG. 6 of the drawings which is representative of the filter rod prepared according to the process and apparatus of the instant invention.

In additions to the visual differences which are readily apparent from a viewing of FIGS. 5 through 8 of the drawings, the rod samples of FIGS. 5 through 8 of the drawings were also analyzed using the "Quantimet" (analytical device manufactured by Cambridge Instrument Company of Monsey, N.Y.) so as to determine fiber orientation angle distributions within the longitudinal sections. Other rod characteristics such as the agglomeration factor and packing fraction also measured the results of which appears in the following table.

Rod Description	System Description	(1)	(2)	(3) $\bar{X}$	(3) σ	(4)	Pressure Drop
3.3 F/ 39,000							

-continued

Rod Description	System Description	(1)	(2)	(3) $\bar{X}$	(3) σ	(4)	Pressure Drop
FIGS. 7 & 8	Example 3 (Prior Art)	.1050	47.1	44.3	15.03	1.47	431
FIGS. 5 & 6	Example 1 (Instant (Invention)	.1225	54.4	51.8	21.20	1.45	626

(1) Packing Fraction
(2) Calculated Crimp Angle
(3) Measured Fiber Orientation ($\bar{X}$ = average, σ = standard deviation)
(4) Measured Agglomeration

Having thus disclosed the invention, what is claimed is:

1. In an apparatus suitable for a range extension process of manufacturing filter elements from opened and deregistered crimped continuous filament tow, wherein said tow is conducted from a mechanical forwarding means through an aspirating jet into a compacting means immediately adjacent said jet and wherein means are provided for dissipating aspirating fluid, the improvement comprising: (a) a tow controlling means positioned intermediate said mechanical filament forwarding means and said aspirating jet, said tow controlling means controlling width and direction and imparting at least some drag to said opened and deregistered tow and; and (b) a perforated funnel member positioned intermediate said aspirating jet and said compacting means, said perforated funnel member having sufficient volume to allow said tow to accumulate in a substantially tension free condition prior to being drawn into said compacting means whereby pressure drop and weight variations in resultant cigarette filter elements are reduced at extended points in range.

2. The apparatus of claim 1 wherein said tow controlling means is a means selected from the group consisting of an idler roll and a stationary rod member.

3. The apparatus of claim 1 wherein a ring guide member is positioned in advance of said tow controlling means whereby tow band width is reduced prior to passage over said tow controlling means.

4. The apparatus of claim 1 wherein the perforations of said funnel are positioned nearest the exit end of the funnel.

5. In a range extension process of manufacturing filter elements from opened and deregistered crimped continuous filament tow wherein the tow is conducted from a mechanical forwarding means through an aspirating jet into an immediately adjacent compacting means and wherein means are provided for dissipating aspirating fluid, the improvement comprising: (a) causing said tow to contact a tow controlling means positioned intermediate said mechanical forwarding means and said aspirating jet, said tow controlling means controlling said width and direction and imparting at least some drag to said tow; and (b) dissipating said aspirating fluids by means of a perforated funnel member positioned between said aspirating jet and said compacting means, said perforated funnel member having a depth sufficient to temporarily accumulate tow in a substantially tension free state prior to the tow being drawn into said compacting means whereby pressure drop and weight variations in resultant cigarette filter elements are reduced at extended points in range.

6. The process of claim 5 wherein said tow controlling means is a means selected from the group consisting of an idler roll and a fixed rod.

7. The process of claim 5 wherein said controlling means is positioned so as to cause said tow to pass through said aspirating jet substantially along the longitudinal axis of the processing bore of said jet.

8. The process of claim 5 wherein a tow width reducing ring guide is positioned in advance of said tow controlling means.

9. The process of claim 5 wherein the terminal portion of said aspirating jet is nested into the mouth of said funnel member and wherein the terminal portion of said funnel member is recessed into a tongue of said compacting means.

* * * * *

Related Proceedings Appendix

There are no decisions by a court or the Board in related proceedings.